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Promotionsverfahren von **Herrn M.Sc. Andre Ippisch**
Auslage der Dissertation und Gutachten sowie Termin der mündlichen Prüfung
Anlage: Einseitige Zusammenfassung der Dissertation

Sehr geehrte Damen und Herren,

in dem oben genannten Promotionsverfahren wird die Annahme der Dissertation

Smartphone-based Frameworks and Protocols for Opportunistic Networking

von den Berichterstattern Juniorprof. Dr. K. Graffi und Prof. Dr. M. Schöttner beantragt. Sie kann zusammen mit den Gutachten in der Zeit

vom 17.12.2018 bis 13.01.2019

im Promotionsbüro (Gebäude 25.32, Ebene 00, Raum 36) zu den Sprechzeiten eingesehen werden.

Einsprüche gegen diese Dissertation können nur zwei Tage nach der vorgenannten Frist geltend gemacht werden. Erfolgt kein Einspruch, so gilt die Dissertation als angenommen (§ 7 Ziffer (5) PO).

Sofern die Dissertation angenommen wird, findet die mündliche Prüfung am

16.01.2019 um 10:20 Uhr

im **Hörsaal 5 M** statt. Als Prüfer sind vorgesehen:
Juniorprof. Dr. D. Baumeister, Prof. Dr. S. Conrad und Prof. Dr. S. Harmeling.

Zuhörer sind bei der Befragung nicht zugelassen.

Mit freundlichen Grüßen
im Auftrag

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Smartphone-based Frameworks and Protocols for Opportunistic Networking

Andre Ippisch

Opportunistic Networks are mobile, delay-tolerant networks with intermittent node contacts in which messages are transferred with the *Store-Carry-Forward* principle. In these decentralized networks, which stand in contrast to the Internet's infrastructure, devices are connected to each other instead of an access point. Many of the current smartphones and apps heavily rely on and are rather useless without Internet access, but this access is not always guaranteed and can be unavailable due to catastrophes, censorship or just dead spots. Additionally, the usage of the Internet might be unwanted because of its dependency on hardware and lack of privacy. Hence for smartphones, Opportunistic Networks can offer a useful addition or alternative to the Internet. Because there are parallels between the movement of people and the dynamics in Opportunistic Networks, and additionally, most people own a smartphone, they have the potential to be a suitable platform for Opportunistic Networks. However, there has not been much work on this combination, and in fact not much work on the use of Opportunistic Networks themselves in practice. To change that, several challenges have to be resolved to establish an Opportunistic Network with smartphones and provide the network application *opptain*.

Building an Opportunistic Network for smartphones requires solutions for the basic challenges of node discovery, connection establishment, and one- and multi-hop communication. To allow a wide applicability of our networking mechanisms, we must use off-the-shelf and unrooted smartphones, possibly with the most widespread operating system. Our first goal is to discover other participating smartphones and to connect to them automatically, which allows our application to create the network without user interaction. Because current smartphones lack wireless ad-hoc network technologies, we present an approach called *Hotspotting* in which the device scans for tethering hotspots of other network participants in the surroundings and, after a successful search, connects to one, else the device itself becomes a hotspot and lets other devices connect to it.

Once the network and one-hop communication is established, our next goal is to enable multi-hop communication with routing protocols that manage the dissemination of the messages in the network. We include routing protocols proposed in literature in our network and improve on them with new replication control strategies. During the establishment of a connection, meta data that is needed for these protocols is gathered and exchanged between two communicating nodes. After the two nodes connect, each node has to decide which messages to forward or replicate to the connected node. Either the nodes always replicate all messages, i.e. flood the network, or local information and the aforementioned meta data are used for replication decisions of more sophisticated routing protocols. To improve the one- and multi-hop communication, we enhance the meta data exchange and use smartwatches as a second signal way.

When nodes can connect and messages are routed through the network, there are still open challenges. To avoid overwriting any user data in the smartphone's shared storage with network messages, we develop a specific buffer management. To allow for the correct processing of the network's time specifications that are exchanged between devices, for example with the remaining *Time-To-Live* of our messages or the global order of messages, we also develop a specific time management procedure.

Having put together all the basic requirements for a working Opportunistic Network, we consider other dynamics that affect the stability of the network, in particular, node density and security. Node density has a high impact on the network since messages are transferred from one device to another, and therefore devices that run our application must meet regularly to establish a functioning network. To show the impact of security in decentralized networks, we conduct a survey of the possible threats and attacks that affect single and multiple devices, in which we also show the proposed solutions and mitigation techniques. Lastly, to evaluate our work, we conduct a field experiment which provides promising results that show that our application can establish an efficient Opportunistic Network.